Helicate

HELICATE · A-LEVEL BIOLOGY · TOPIC BANK

3.7.2 Populations

Topic question bank

Version 1 · 16 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
5	45	No time limit	/ 45

Contents

Subtopic	Questions	Marks
Populations and gene pools Specification 3.7.2	01	7
The Hardy-Weinberg principle and equation Specification 3.7.2	02–03	16
Testing Hardy-Weinberg predictions in the field Specification 3.7.2	04–05	22
Total		**45**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA A-level Biology (7402), specification section 3.7.2. Not affiliated with or endorsed by AQA.

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Populations and gene pools 3.7.2

The common toad, *Bufo bufo*, is found across most of Britain. Each spring, most adult toads return to the pond where they hatched in order to breed. Ponds used by toads are often several kilometres apart.

0 1 . 1 Which of these is a population?
Tick (✓) one box.

[1 mark]

- All the common toads and common frogs breeding in one pond in one spring ☐
- All the common toads breeding in one pond in one spring ☐
- All the common toads that have ever bred in one pond ☐
- All the female common toads breeding in one pond in one spring ☐

0 1 . 2 Ecologists studying common toads treat the toads that breed in each pond as a separate population.
Use the meaning of the term population to explain why.

[2 marks]

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0 1 . 3 Give the meaning of the term gene pool.

[1 mark]

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Question 1 continues on the next page

Do not write outside the box

0 1 . 4 Ecologists want to use the Hardy-Weinberg principle as a mathematical model of the toad population at one pond.
Describe what the principle predicts for this population and the conditions under which it would apply.

[3 marks]

7

Turn over for the next question

Do not write outside the box

The Hardy-Weinberg principle and equation 3.7.2

Arctic foxes, *Vulpes lagopus*, grow a thick winter coat. One gene controls the colour of this coat. The allele **B** gives a blue (dark grey-brown) winter coat and is dominant to the allele **b**, which gives a white winter coat.
In a survey of a large, randomly mating mainland population, 99 of 2500 foxes had blue winter coats and the rest had white winter coats.

0 2 . 1 What is the frequency of the **b** allele in this population?
Tick (✓) one box.

[1 mark]

0.02 ☐

0.04 ☐

0.96 ☐

0.98 ☐

0 2 . 2 In the Hardy-Weinberg equation, the frequency of heterozygous foxes is 2*pq*, not *pq*.
Explain why.

[2 marks]

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Question 2 continues on the next page

Do not write outside the box

0 2 . 3 Calculate the percentage of the blue foxes in this population that the Hardy-Weinberg equation predicts are heterozygous.
Show your working.

[3 marks]

Answer _____ **%**

0 2 . 4 Arctic fox litters usually contain five or more cubs.
Use your answer to 02.3 to explain why most matings between two blue foxes in this population would be expected to produce some cubs with white winter coats.

[2 marks]

8

Turn over for the next question

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Foxes also live on an island close to the mainland. The island population is large. Much of the island has dark, rocky ground. Most foxes on the mainland have white winter coats. In winters when the sea freezes, foxes can cross between the mainland and the island on the sea ice.

Scientists used DNA from hair samples to find the genotypes of foxes on the island in 2000 and in 2020. Table 1 shows their results.

Table 1

Year	Number of foxes tested	Number of foxes with each genotype		
		BB	**Bb**	**bb**
2000	160	30	78	52
2020	175	50	90	35

0 3 . 1 Which of these would **not**, on its own, stop the Hardy-Weinberg principle applying to the island population?
Tick (✓) one box.

[1 mark]

Blue foxes being more likely to mate with blue foxes than with white foxes ☐

White foxes crossing to the island on sea ice ☐

Blue foxes catching more prey on dark rocky shores than white foxes ☐

Foxes of both coat colours dying of old age at the same rate ☐

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 Use the numbers of each genotype in Table 1 to calculate the frequency of the **B** allele on the island in 2000 and in 2020.
Give each answer to **two** decimal places.

[2 marks]

Frequency in 2000 .....

Frequency in 2020 .....

Question 3 continues on the next page

Do not write outside the box

Since 2000, snow has covered the island for fewer weeks each winter, and the sea between the island and the mainland has frozen in fewer winters.

0 3 . 3 Use Table 1 and the information given to suggest explanations for the change in the frequency of the **B** allele on the island between 2000 and 2020.

[5 marks]

8

Turn over for the next question

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Testing Hardy-Weinberg predictions in the field 3.7.2

In the scarlet tiger moth, one gene with two codominant alleles, W^T and W^M, controls the pattern of spots on the forewings.

A survey of a large sample of moths from a large colony found that the frequency of the W^M allele was 0.10.

One year later, students caught 600 adult moths with nets in one meadow at the edge of the same colony on a single sunny day. They recorded the wing pattern of each moth, then released it. Table 2 shows their results.

Table 2

Wing pattern (phenotype)	Genotype	Number of moths caught
Typical	W^TW^T	517
Medionigra	W^TW^M	80
Bimacula	W^MW^M	3

The students used a chi-squared test to find out whether their results differed significantly from the numbers expected if the frequency of the W^M allele was still 0.10.

0 4 . 1 Give the null hypothesis for this test.

[1 mark]

Question 4 continues on the next page

Do not write outside the box

0 4 . 2 Use the Hardy-Weinberg equation to calculate the number of medionigra moths expected in a sample of 600 moths if the frequency of the W^M allele was still 0.10.
Show your working.

[2 marks]

Answer ..... **moths**

0 4 . 3 The formula for the chi-squared test is

$$\chi^2 = \Sigma (O - E)^2 \div E$$

where O is the observed number and E is the expected number.
Calculate the value of chi-squared for the students' results.

[3 marks]

Answer .....

Question 4 continues on the next page

Do not write outside the box

Table 3 shows critical values of chi-squared.

Table 3

Degrees of freedom	1	2	3	4
Critical value of chi-squared at $P = 0.05$	3.84	5.99	7.82	9.49

0 4 . 4 Use your answer to 04.3 and Table 3 to give the conclusion of the students' test. Explain your answer.

[3 marks]

0 4 . 5 Count the alleles in the students' sample to calculate the frequency of the W^M allele.
Give your answer to **two** significant figures.

[1 mark]

Answer .....

Question 4 continues on the next page

Do not write outside the box

0 4 . 6 A student concluded that birds had eaten more medionigra and bimacula moths than typical moths since the survey, and that this had caused the change in the frequency of the W^M allele.
Evaluate the student's conclusion.

[4 marks]

0 4 . 7 Suggest **two** ways the students could improve their sampling so that their results better represent the whole colony.

[2 marks]

1

2

16

Turn over for the next question

Do not write outside the box

In the grove snail, *Cepaea nemoralis*, one gene controls whether the shell has dark bands. The allele for an unbanded shell is dominant to the allele for a banded shell. A large population of grove snails lives in a hedgerow and grassland area of about 2 hectares.

0 5 Describe how students could collect data from this population and use them to estimate the frequency of the allele for a banded shell.
Include any assumption that the students would need to make.

[6 marks]

6

END OF QUESTIONS

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